

---

**FIRST MAJOR IMPROVEMENTS TO THE TWO-CURVE DUCTILE FRACTURE  
ARREST MODEL – EFFECT OF DIFFERENT SOIL TYPES ON DUCTILE  
FRACTURE ARREST, AND SEPARATING ELASTIC AND PLASTIC  
CONTRIBUTIONS TO THE CRACK-DRIVING FORCE**

---

### **Summary**

The objective of the proposed program is to make the first major improvements to the most commonly used ductile fracture arrest criterion. There are two tasks in this effort.

The first task is to improve the accuracy of the Two-Curve Ductile Fracture Model to be able to account for different types of soil backfills, i.e., sand, clay, etc. To make this improvement, a series of intermediate-diameter (6 to 12-inch) pipe burst tests with different soil types, compaction, and moisture content will be conducted at the Emc<sup>2</sup> burst test site in the Mojave Desert in California.

The second task involves making an improvement to the crack-driving force equations in the Two-Curve Method so that there will be elastic and plastic contribution to the crack-driving force. Experimental results have shown that the arrest toughness value determined from the Two-Curve Ductile Fracture Model should be continually increased as the grade of the pipe is increased. A significant portion of this empirical correction comes for the elastic energy being higher than was accounted for in the current Two-Curve Ductile Fracture Model. Making this improvement will allow for safer future pipeline design with higher-grade steels.

### **Progress as of June 2004**

Work is well underway in preparation for the first series of six Mojave burst experiments, which will occur at the end of August 2004. Pipe has been procured and is in the process of being characterized. Initial instrumentation plans have been discussed, which include timing wires, pressure transducers, thermocouple, and possibly some advanced instrumentation to measure loads between the pipe and soil.

Quotes have been requested from soil engineering companies to aid in trench preparation, location of other soils to truck in, and the measurement of in-situ soil properties such as moisture, compaction, shear and compressive strength.

A draft agreement has been written by Emc<sup>2</sup> for information exchange between this program and a larger scale ongoing program conducted by the Japanese Gas Association. The initial agreement will be between PRCI and JGA with the provision that PRCI will share the data with DOT. Similar larger diameter experiments will be conducted in the JGA program and a cooperative data exchange will occur between these programs.